



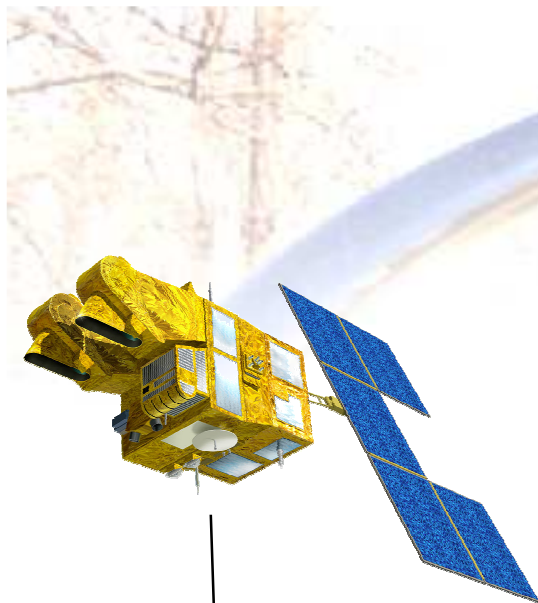
# **Ground station architecture : trade-off and cost**

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# SUMMARY

- ⇒ **SYSTEM ANALYSIS**
- ⇒ **APPLICATIONS**
- ⇒ **STATION ARCHITECTURE TRADE-OFF**
- ⇒ **FAMILIES of ANTENNAS**
- ⇒ **COST/PERFORMANCES COMPARISON**
- ⇒ **EXAMPLE of DESIGNS**

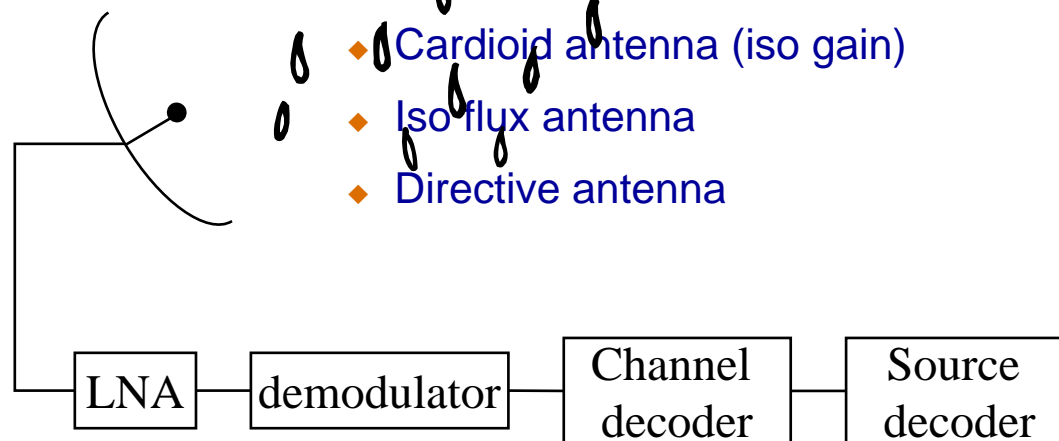


### Ground station transmitter :

• CCSDS compliant decoders and modulators  
 • Propagation : (100 to 200 dBW)

• Rain attenuation exceeded during 5 to 0.5 %  
 • On-board antenna

- ◆ Cardioid antenna (iso gain)
- ◆ Iso flux antenna
- ◆ Directive antenna





# SYSTEM ANALYSIS

## ⇒ **BOARD TO GROUND INTERFACE :**

- isoflux on-board antennas: system margin limited at low elevation (typically  $5^\circ$ ), and increases slightly as elevation increases
- Pointed on-board antennas : high system margin as elevation increases

## ⇒ **Rain Availability:** from 0.95 to 0.99

- Depends on the location of the station, and the system availability allocated to the mission

## ⇒ **Orbit prediction accuracy :**

- typically 500 m accuracy along the orbit in routine and after manoeuvre
- pointing parameters extracted from SGP4 propagator with an accuracy roughly better than  $0.04^\circ$



# APPLICATIONS

## ⇒ CIVIL MAIN MISSIONS : $R_b > 50$ Mbps (SPOT, ENVISAT...)

- ◆ starting from  $5^\circ$  of elevation, all latitudes, high RF link availability ( $> 98$  ou  $99\%$ ), operation station availability (around 0.975)
- ◆ Medium investment and operation cost

## ⇒ SCIENTIFIC MISSIONS : $R_b < 50$ Mbps (DEMETER, MODIS...)

- ◆ 10 to  $15^\circ$  of elevation, no extremes latitudes, medium RF link availability ( $> 95\%$ ), low station availability ( around 0.95)
- ◆ low investment and operation costs

# STATION ARCHITECTURES TRADE-OFF

## ⇒ ANTENNA AND PEDESTAL

- ◆ Cassegrain geometry with conformed reflectors : from 5.5 m diameter antenna, high efficiency
- ◆ Prime focus geometry : for low cost antenna, small diameters
- ◆ Zenital tracking capability without loss : X/Y or hexapod or AZ/EL/Third axis mounts
- ◆ With or without auto tracking

## ⇒ BASEBAND, ingestion, M&C, tests

- ◆ multi mission demods (FGPA coding...)
- ◆ integrated functions :
  - demodulation and ingestion,
  - M&C and antenna control unit...

## Families of antennas

- ⇒ 13 m antennas :  $G/T > 32$  dB/K, better protection against interferences (but tracking can be touchy), costly (infrastructure, maintenance), auto track required
- ⇒ 5.5m to 7.3 m antennas :  $G/T > 30.5$  dB/K, good link margin for main missions from  $5^\circ$  of elevation, auto track, Cassegrain conformed geometry
- ⇒ 3.4m to 4 m antennas:  $G/T > 25$  dB/K (SFCG Recom 18-2), good link margin main missions from  $10^\circ$  of elevation, program track, prime focus or cassegrain feed,
- ⇒ 3..1m to 3.4m antennas :  $G/T > 21$  dB/K, good link margin scientific missions from  $10^\circ$  of elevation, prime focus

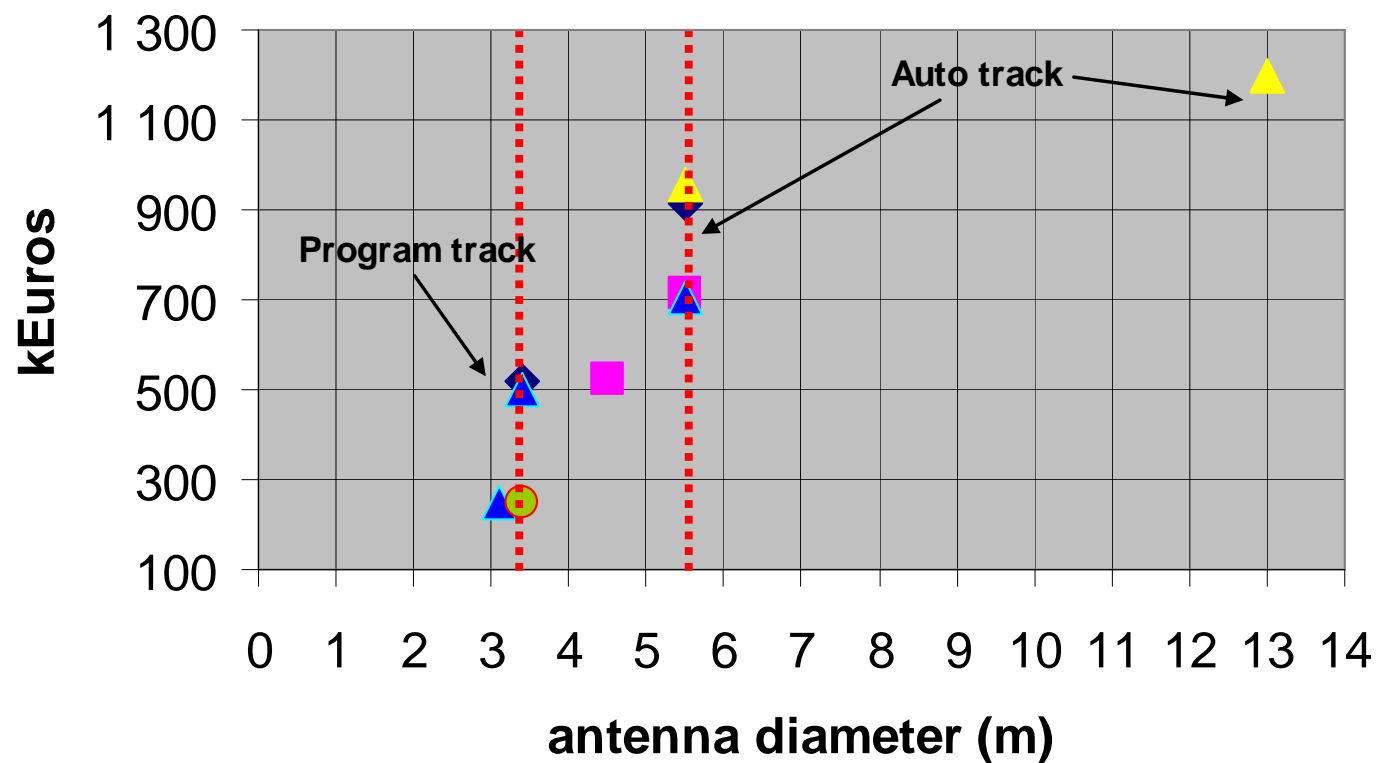
**NB: Improvement of  $G/T$  with low cost cryo-LNA (single stage cryo pump) : around 2 dB**

# COST COMPARIZON

- **Standard Configuration :**
  - ◆ Mono mission (SPOT or ENVISAT or ...)
  - ◆ Two-channels demodulation and ingestion chains down to the CADU formats recording
  - ◆ Auto track or Program track according to the antenna size
  - ◆ Baseband Single Redundancy
  - ◆ Fully automatic and remotely operation capability
- **Cost share:**
  - ◆ antenna and pedestal > 70 % of total

# Typical Station Costs

## Station costs (Baseline configuration)





# EXAMPLES OF DESIGNS

- X/Y pedestal ( 3.4m to 6 m )
  - ◆ SLS...
- Hexapod (3.4 m to 6 m)
- AZ/EL/ tilt ( 6 m to 13 m)